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Evaluation of care indicators while using an analog and digital test designed to cognitive training in older adults

Claudia Rojas Rodríguez[a]*, Daniel Felipe Jiménez[b]

[a]*Universidad Pedagógica y Tecnológica de Colombia. 110121Colombia*
[b] *Carpe Diem Group Corporation, Bogota. 110121 Colombia*

Abstract

This paper describes the methods and findings of the first application in laboratory conditions of analog and digital prototypes from a test designed for cognitive training for older adults. Since the content of the test privileged the cognitive processes of solving problems related mainly to sustained and selective attention, and since some studies have shown that these processes improve when the demands of the job match the capabilities of people, it was considered important to investigate the discriminatory conditions of these processes of care when older adults face interaction tasks with digital devices compared with analog devices of the same features and content.

The test is designed primarily intended to serve as a pretext to collect data related to interaction design in this population, and developed from the disaggregated mental model of the interaction with a specific technological equipment, although uses conventions and implicit concepts in designing of various digital interfaces to enable intuitive navigation to other models. This process included the participation of designers and therapists supported by the philosophies of co-design and participatory ergonomics.

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* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
*E-mail address:*claudia.rojas@uptc.edu.co

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1. Introduction

Interaction design must understand how learning to use interfaces is given in each population group to promote the conceptual representation of the equipment is accurate, consistent and complete to adequately guide the design of the devices and their documentation. However, technology changes constantly generate environments and systems in which the interaction takes place sometimes without considering the human condition from those operating the systems. This situation is more critical for some seniors since aging progressively deteriorates the properties and capabilities of different organs of the human being, including mental functions.For several years design theorists promote responsibility to actively participate from the profession in understanding and handling of any product so it can be used by a senior despite its limitations, "design for the young and you exclude the old; design for the old and include the young"[1]status, claiming in their considerations requires specific analyzes of perceptual systems, manual operation and mental abilities. In particular cognitive decline in old age is characterized by neuronal plasticity, reason for "why have been designed various programs, so that once detected cognitive impairment can act to ameliorate or prevent further damage" [2]. In clinical practice, the therapist selects from the assessment of tests and training available those which prove to be more appropriate for the condition of each individual but generally the tests converge several items to evaluate different cognitive functions; however, some who have already been tested and primarily those that improve the skills of daily living, report favorable effectiveness data in anyspecifiedd trained dimension. For this reason it was decided to design a test focused on the training of a single cognitive dimension, and highly relevant to the daily life of any human being: attention.

1.1. The human attention process

Some research suggests that the behavior of care presents significant changes with age manifest as a decline in the rate of accuracy in detecting signals, therefore the project considered of interest get closer to the theories related to cognitive processes since the objective of the project focuses on understanding the use of technological interfaces involving timely manner skills related to problem solving, study is concerned especially tasks that require focus on some information, or those that involve no deconcentrated by the presence of irrelevant information in summary tasks that relate to attentionn processes.The attention is not confined to a single definition, however the project addresses the concept of attention as a property of the functional system "consists of selectively focus our consciousness, filtering and discarding unwanted information ... .Attention therefore requires a neurocognitiveeffort which precedes perception, intention and action" [3], and consequently properties that interfere with the ability to interact effectively with the different systems designed. According Mesulam "the aspects that define the integrity of care would be orientation, exploration, concentration and alertness, while the impersistence distractibility confusion and neglect reflect their deficits "(cited by [3]).

Given the enormous complexity of intervening variables in this human brain function, the project was particularly interested in two dimensions: selective attention and sustained attention. This is because selective attention is related to visual search, "the ability to select from several possible information the relevant to be processed or outline appropriate action"[4],and attention sustained capacity to maintain alertness to several stimuli or "events that happen quickly or slowly over a prolonged period of time" [5]. These processes are implicit in understanding of knowledgeand learning of any interactiontask, and are determined by the quality and physic characteristics of the designed and selectedstimuli.

1.2. Analogic and Digital

In most developed countries, digital technology has almost completely replaced the analog contents in a large number of applications, but probably analogue mode never disappear for some features of use and interpretation that compared remain more beneficial. In particular the interests of this project to understand which cognitive processes are benefiting or diminished when tests designed and implemented are presented to patients in a form or another. Some theorists argue the relevance of working with analog representations for the positive development of cognitive activities and likewise other authors advocate the benefits for learning and memory favor digital representations, this mainly referring to education.Argumentations between analogicand digital begin in the pragmatic to the discursive

and cognitive, however it can be denied that most of the mental process emerge from images or symbols that can be compare since "men thinks by using perception and perceive whit help from thought". It's thought is an analog thinking, a seer thought ….the decisive is the perception from different contents some next to others, that can be compare, that produce an analogy "[6], as neither can disown that doubtless the advancement of technic science makes men a more digital being every day.

Digital environments offer models that promote autonomy and programing of hierarchic difficulty levels even the instructions to do it in a self-guided way [7], however previous argumentations generate controversy when thinking on cognitive training, because it propose that digital environments discharged the apprentice the responsibility to memorize all process which goes wrong way with therapies. From this controversy emerges the question that guides this section of the study ¿what are the implications of the nature of analog or digital test on the specific dimension of attention training?

2. Methods and Materials

All Considering objectives of the study, research design is almost experimental and analytical and is develop from a combined approach, in a first moment with a qualitative research nature for design were the designed constitutes in a pretext to collect data and a second moment with an experimental nature supported by quantitative measurement techniques in the laboratory. In the first research moment involved the application on a group of 12 people conformed by therapy assistants from the Meredi Hospital ascribed to University of Rosario and the Caracola day home, booth in Bogota city, those people were previously informed about the study and the approved to participate on it, those who applied the standardized proves Lotca, Neuropsi and Purdue. This tests were selected since they involve evaluation parameters and criteria very precisely that do not consider inductive categories, aloud to formulate transversal qualitative categories because they include various items that evaluate language or semantic process, abstract process from numeric operations and figurative process, aspects that are implicit on the design of interaction forms that facilitated the analysis from the parameters interest of this study.

From the results of the application of these standardized test, it was conceptualized the design of the training prove and placed on evidence the need to established differences between occurred with attention process when the test is applied through traditional approaches compared to the application of a digital model. Coherence whit this conclusions a cognitive training test was designed in an analogical a digital version. This test comprises three intervention levels: basic, medium and advance, each one including cognitive semantic process, abstracted and figurative. Once the analog and digital test were designed and its protocols determined the importance before evaluate specific content of the test, analyze accomplishment of proposed functionality it means the activation or stimulation of the process of sustained and selective attention which corresponds to the second moment of the study designed from a qualitative and almost experimental nature. The second moment was supported by qualitative measurement technics on the laboratory even when attention as a mental process involves a great number of biological indicators this study was interested mainly in measurable elements useful for the final design of the test.

Among the technological possibilities that refer precise data for this porpoise the Biofeedback and Eye tracker equipment's were found since there are many reports related to weaves measurement and eye behavior during activities involving attention stimulation process. Biofeedback is an equipment for neurophysiological exploration based on the registration of cerebral bioelectric activity in conditions of rest or activity, its registration is given by cerebral waves. Weaves registered by this equipment are among others; alpha with an amplitude between 13 and 30 Hz are related with activity rom moderated vigil and rest. Beta waves with amplitude between 13 and 30 Hz are related with intense mental activity, alert and problem solving. Theta weaves with amplitude between 4 and 7 Hz related to lack of sleep in its previous phase ad creative process and Gamma weaves that for part of the Betas and related to complex activities, because of this some studies ensure that take an important role in the process of attention. Eye tracker is an ocular tracing equipment that studies the way people observe by capturing data from sight and dilatation of pupil and associating them with behavior and understanding of perception mechanisms of perception and cerebral function giving valuable information for multiple applications.

This test stage was realized in collaboration of UNAM (Mexico) Design Faculty Ergonomic Lab, where are the two selected equipment and the required conditions to the controlled process development that has been done during

September and November 2014. In addition, the Coyoacán Older Adults Center support the process, place where the nine (9) older adults accept take part in the project and were previously informed about the study and signed the written request inside the frame of the programed activities under the etic normative. In spite of this stage was a quantitative approach, the project took the coexistence criteria to the data collection in the sample because the macro study is an qualitative-comprehensive approach, this was the reason why the study was accompanied with ethnographic and narratives techniques in order to improve new inductive analysis categories.

To begin, the program was organized to the shuttle days of the older adults to the lab. Once there, was applied consecutively the analogic and digital test to each participant, respectively. Begins with the presentation of the equipment, the sensors placement in strategic points of participant head and the eye tracking diadem, followed by the equipment calibration in its action space. Later was informed about the test development spaces and the behavior instructions during the process. The test begin with the collection of basic data, and the test level determination of each participant in which they will could advance in function of their knowledge using the base technology used in the design conceptualization. Later the limitless time tests began.

In general the average analogic test duration was 32 minutes and 20 minutes in the digital one. The analogic test development besides being registered in the test specific designed protocols, it was recorded audio and video. The digital test application was registered in external and internal video, and in the data base designed to recognize the data in this mode. For each one of the participants the equipment's shows the curves and numeric data related with the waves emitted and the pupil dilatation grades and location while the process. In the qualitative techniques data was taken verbally the final impression in each participant related with their tests performance in the two modes.

Once applied the test to the whole persons involved in the sample, the tests was applied in the same process conditions, in two persons with less of 30 years old, postgrade university students, who have a wide knowledge and management in technologic systems, the above with the objective to take this data as a control or concerning during the analysis process.

3. Results and Discussions

To this study in consideration of the formulated approaches from the experiments results and several theories of investigators was determined, make the first results approach to relating in particular to the beta waves activity in order to identify the selective attention process and the relation between the beta waves and theta waves to identify the sustained attention process activation [8].So, in the first recollected material revision it was concluded in a general approximation to the sustained and selective attention variables that the theta waves are activate during the tests process analogic and digital. In general in the participant persons record is registered a high wave activity in the beginning of the test, in the change of process and levels, but with more intensity in the stage of sequences elaboration. In older adults the high wave amplitude goes to 22 Hz, (see graphic 1) and in the youngest people in the control group achieve 30 Hz, there is a similar behavior between digital and analogic test.From here is deduced that the test stimulate the general attention process. In reference to the relation with beta waves is pretty meaningful the behavior difference between the older and young people, to the study interest group the beta waves maintain very low during the analogic test with some exceptions but they altered in concordance with variability in theta waves.

To the control group, beta waves maintain high curves during the whole test and in particular increases during the process changes and levels. In relation with the test versions comparison is also important relate that beta waves have an increment in the records of older adults during the digital test, and for the control group the difference between tests is not perceptible. (See graphic 2). This data allows indicate that the designed tests stimulate the selective attention, but nevertheless, being that was found an important low in the beta/theta waves record, some studies have raised that when this record exceed the 50% is related with a clear attention deficit[8] for this reason now is being reviewed the relation between this find with the effectiveness deficit in each execution level in the test.In similar way is considered important make a more adjusted study in process timing and the numbers of execution mistakes, for this was designed a format to register each participant data and proceed to make the transcription of the time in each process and level with the videos taken during the digital test, now is being obtained this new biofeedback reports to make the sustained and selective attention analysis in each cognitive process, in a

precise way, and compare this processes in the two test modes: analogic and digital to make the first meaning construction.

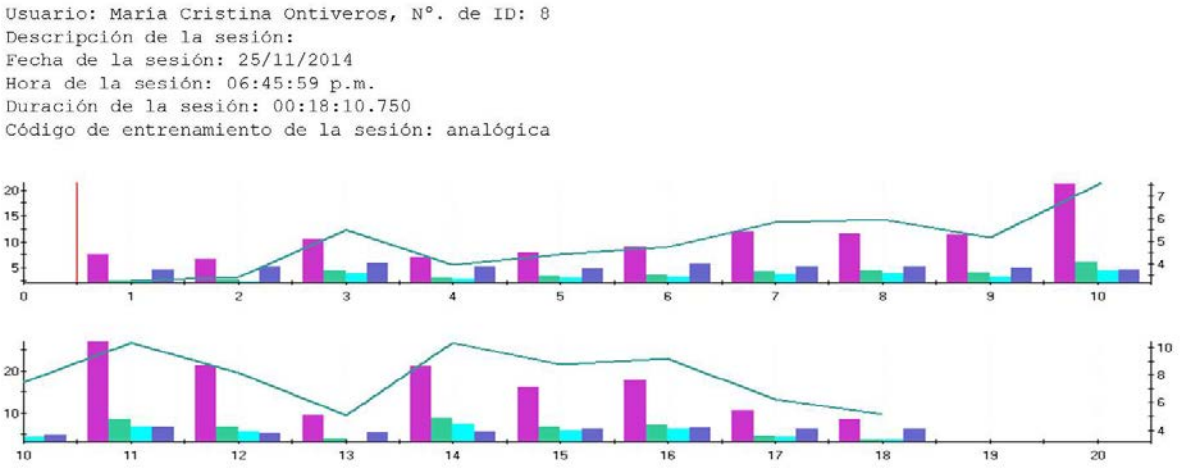

Fig. 1. Biofeedback Report Model, Analogic Test (2014)

Equations About the eye tracker, is concluded that the data is too irregular because the participants decompose the equipment constantly therefore the record is not very reliable, but nevertheless, because of the pupil dilatation data stay stable in all records, it was established that the pupil dilatation varies in relation with the two groups, in the older persons the diameter varies between 37 and 48mm while in the young people group the variability is found between 52 and 65mm. this variability ,increase and decrease in relation with the beginning of the cognitive process evaluated by the test content, and it shows in similar way between the analogic and digital versions. This data must be related in the same way with the execution results and mistakes, and off course with the specific times of the previously described waves.

4. Conclusions

From the compressive categories, the first data shows that the persons have more easily learning with the analogic test because of the familiarity and tranquility generated by the relation with the tangible pieces and buttons, however, once the learning has been given is much easier to the older adult resolve the tests in the digital mode, this maybe is because of the implicit processes in the digital test design that uses most of all compare/selection processes, and the analogic test includes a good number of identification or definition processes that in general shows a major difficulty grade. This also can be seen in the shortest times used to make the digital test, also in the number of successes and mistakes. In conclusion, still needs to be done several analysis and correlation processes in the obtained data in order to respond the question between analogic and digital in cognitive training for older adults, but apparently the final results will allow formulate some theoretical approximations, and redesign the test versions.

References

[1] Haigh, R (1993).The ageing process: A challenge for design. Applied Ergonomics, 24, 9-14.
[2] Gramendi, F., Delgado, D. & Amaya, M. (2010).Programa de entrenamiento cognitivo en adultos mayores. Revista Mexicana de medicina física y rehabilitación, 22, 26-31.
[3] Estévez-Gonzáles, A., García-Sáchez, C. &Junqué, C. (1997) La atención: una compleja función cerebral. Revista de Neurología. Universidad de Salamanca España .25 (148) 1989-1997

[4] Rebollo. M, Montiel, S. (2006). Atención y funciones ejecutivas. Revista de Neurología Universidad de Salamanca España. 42(Supl 2) 3-7
[5] García –Ogueta, M. (2001), Mecanismos atencionales y síndromes neuropsicológicos. Revista de Neurología Universidad de Salamanca España. 32(5) 463-467
[6] Aicher O. (2001). Analógico y digital. Barcelona, España: editorial Gustavo Gilli
[7] Cassany, D. (2001). De lo analógico a lo digital. El futuro de la enseñanza de la composición. Revista Lectura y Vida. Barcelona.
[8] Álvarez, L., González-Castro, P., Núñez J, González- Pineda, J & Bernardo, A. (2008) International Journal of Clinical and Health Psychology. Vol. 8, Nº 2, pp. 509-524